

[0019] FIG. 6(a-b) illustrates a haptic cell employing Micro-Electro-Mechanical Systems pumps to generate haptic effects in accordance with one embodiment of the present invention;

[0020] FIG. 7 illustrates a side view diagram for an interface device having an array of haptic cells using variable porosity membrane in accordance with one embodiment of the present invention;

[0021] FIG. 8 is a side view of an interface device having an array of haptic cells using various resonant devices in accordance with one embodiment of the present invention; and

[0022] FIG. 9 is a flowchart illustrating a process of providing locating features on a deformable haptic surface in accordance with one embodiment of the present invention.

DETAILED DESCRIPTION

[0023] Exemplary embodiments of the present invention are described herein in the context of a method, system and apparatus for providing fixed relief information to a touch screen with locating features using a deformable haptic surface.

[0024] Those of ordinary skilled in the art will realize that the following detailed description of the exemplary embodiment(s) is illustrative only and is not intended to be in any way limiting. Other embodiments will readily suggest themselves to such skilled persons having the benefit of this disclosure. Reference will now be made in detail to implementations of the exemplary embodiment(s) as illustrated in the accompanying drawings. The same reference indicators will be used throughout the drawings and the following detailed description to refer to the same or like parts.

[0025] In the interest of clarity, not all of the routine features of the implementations described herein are shown and described. It will, of course, be appreciated that in the development of any such actual implementation, numerous implementation-specific decisions must be made in order to achieve the developer's specific goals, such as compliance with application- and business-related constraints, and that these specific goals will vary from one implementation to another and from one developer to another. Moreover, it will be appreciated that such a development effort might be complex and time-consuming, but would nevertheless be a routine undertaking of engineering for those of ordinary skilled in the art having the benefit of this disclosure.

[0026] An interface device capable of providing a fixed relief touch panel with locating features using deformable haptic surfaces is disclosed. The device, in one embodiment, includes a haptic mechanism and a touch-sensitive surface. The haptic mechanism provides haptic feedback in response to an activating command. The activating command can be initiated by a user or a logic device. The touch-sensitive surface is capable of changing its surface texture or surface relief from a first surface characteristic to a second surface characteristic in response to the haptic feedback. For example, the first surface characteristic may include a coarse texture while the second surface characteristic may include a smooth texture. A function of the exemplary embodiment(s) of the present invention is to provide fixed relief information of a touch panel to a user(s) when the device is activated. It should be noted that the mechanism of providing a deformable-fixed relief surface is applicable to smooth flat surfaces or coarse non-flat surfaces.

[0027] FIG. 1A is a block diagram 100 illustrating a fixed relief display having one or more programmable relief func-

tionalties in accordance with one embodiment of the present invention. Diagram 100 illustrates a top view of an interface device 106 having a location pattern illustrating buttons and sliders. Diagram 110 is a side view or cross-section view of interface device 106, which illustrates a coarse textured deformable surface with a pattern of raising shaped features 102. Interface device 106, in this example, includes a set of nine (9) buttons 102 and a slider 104. When interface device 106 is activated, various predefined areas 102 begin to rise emulating physical edges of buttons and slider 104. In an alternative embodiment, device 106 includes different input objects with different shapes such as bars, keys, balls, rings, and the like. It should be noted that interface device 106 can be used as a user interface device for a cellular phone, a personal digital assistant ("PDA"), an automotive data input system, and so forth.

[0028] Interface device 106 provides a pattern of locating features as relief information, which assists a user to pinpoint exactly where to press on a touch-sensitive surface. Interface device 106, in one embodiment, uses one or more actuator(s) to activate the pattern of locating features. When the actuator (s) is activated, the surface of interface device 106 forms relief information with a pattern of locating features. The surface of interface device 106, however, returns to its smooth surface when the actuator is deactivated. It should be noted that a function of the one embodiment of the present invention is to allow an interface device to form a pattern of locating features when it is desirable. It should be noted that the underlying concept of the exemplary embodiment of the present invention would not change if one or more blocks or layers were added to or removed from device 106.

[0029] The haptic mechanism, in one embodiment, is operable to provide haptic feedback in response to an activating command, and a touch-sensitive surface is capable of changing its surface characteristic from coarse texture to smooth texture or vice versa. The haptic mechanism provides multiple tactile or haptic feedbacks wherein one tactile feedback may be configured to be used for surface deformation, such as by emulating buttons, while another tactile feedback is configured to be used for input confirmation, such as through generating a vibration. The haptic mechanism, for example, may be implemented by various techniques, such as vertical displacement, lateral displacement, push/pull technique, air/fluid pockets, local deformation of materials, resonant mechanical elements, and the like.

[0030] Vertical displacement, in one embodiment, includes a set of pins, wherein the pins are configured to move in a vertical direction between layers such as a touch surface layer and a display layer. The lateral displacement of haptic mechanism, on the other hand, employs a lateral displacement mechanism to create a coarse textured surface and/or a smooth textured surface in response to the lateral direction of movement of the layers to be shifted. Other haptic mechanisms for generating haptic feedbacks are available, such as air-pockets haptic mechanisms, piezoelectric materials, and the like. It should be noted that the haptic mechanism may include multiple cells or regions wherein each cell or region can be independently controlled or activated. Interface device 106 illustrated in FIG. 1A is a single region configuration.

[0031] The touch-sensitive surface, for example, may be a flexible and/or deformable surface, which is capable of sensing finger touches or contacts on the surface. The surface texture or surface relief of the touch-sensitive surface, in one embodiment, can change from coarse to smooth texture or